Low Cost Solutions for Managing Large Diameter Pipelines - High-Tech Systems for Assessment, Maintenance and Refurbishment

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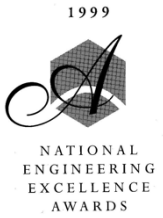
Abstract

The world's ageing pipeline infrastructure continues to decline. Large diameter pressurised pipelines are reaching the end of their economic lives and their owners and operators have few tools available for reliably assessing their condition, analysing their renewal options, and extending their effective lives. Through a successful nine-year research programme, the Water Corporation of Western Australia has developed groundbreaking asset optimisation techniques, equipment and capabilities. These methods result in renewal costs as little as 25% of the benchmark cost of conventional alternatives and defer the major cost of wholesale pipeline renewal by 20 years or more. This is the key to slashing the whole of life costs for the asset by 50% or more.

Over the past 20 years, much focus has been placed on developing trenchless inspection and repair techniques for small to medium diameter gravity pipelines, whilst large diameter pressurised pipelines have been largely ignored, due to the difficulty and cost of accessing these pipelines for condition assessment and repair. This has resulted in a lack of reliable condition data and an ad-hoc asset management approach based on low maintenance, reactive repair and wholesale rehabilitation or replacement. The asset optimisation techniques and equipment developed and patented by the Corporation provide cost-effective solutions to these problems, dramatically increasing the economic lives of such pipelines, thereby slashing their whole of life costs. These award winning capabilities will therefore have a dramatic impact on the way large diameter pressurised pipelines will be managed in the future.

Keywords: Asset, Pipeline, Renovation, Refurbishment, Rehabilitation, Replacement



EXECUTIVE SUMMARY

Over a nine-year period of successful innovation, the Water Corporation of Western Australia has developed an asset optimisation capability that dramatically reduces the whole of life costs for large diameter pressurised pipelines. This capability includes:

Condition Assessment - Sophisticated equipment for assessing, monitoring and reporting on the condition of pipelines over their asset life;

Financial Modelling - Tools to facilitate the selection and management of the best whole-of-life renewal options;

Pipeline Refurbishment - Two distinct processes:

Selective Refurbishment – where the majority of the existing internal lining has substantial residual life and only the failed lining is renewed;

Wholesale Refurbishment – where it is uneconomic to selectively refurbish the existing lining, thereby requiring total removal and replacement with new;

Equipment and Flexibility - A set of unique and patented equipment to facilitate pipeline access, condition assessment, maintenance and refurbishment. Both wholesale and selective refurbishment can be completed economically using the same equipment and crews so that only the lining that has actually failed need be refurbished. This leads to significant cost savings as this lining is quickest and most cost-effective to remove and the optimum blend of selective and wholesale refurbishment can be undertaken. This is the key to slashing the whole of life costs for asset renewal by 50% or more;

Customised Solutions - The technologies are extremely functional and adaptable, enabling the rapid and cost-effective development of customised solutions to suit the particular constraints of individual clients and projects;

Proven Performance - A proven track record for using the systems in the field and for driving continuous improvement. This has seen the costs of pipeline renewal reduced to 15% - 40% of the benchmark rates at the start of the project.

BACKGROUND

Business Drivers - A Water Utility Perspective

- The Water Corporation of Western Australia has over 42,000km of ageing water, sewerage and drainage pipes which have a replacement cost of $6.6billion;
- The business is driven by the cost of these assets and maximising their life at lowest whole-of-life costs is therefore crucial to reducing costs in the long term.

Traditional Asset Management Approach and Techniques for Large Diameter Pressurised Pipelines

- Over the past 20 years, much focus has been placed on developing trenchless inspection and repair techniques for small to medium diameter gravity pipelines;
- By comparison, little investment has been made into No-Dig techniques for large diameter pressurised pipelines. Significant contributors to this situation have been:
  - Trunk water mains are often strategic or sole supply mains which are more difficult, time consuming and expensive to shut down for sufficient time to allow scouring, inspection, repair, disinfection and/or recharge;
  - The greater distance between manholes and smaller manhole openings make ingress and egress for personnel and equipment more difficult and expensive;
  - The greater corrosivity of sewerage has led to significant degradation of much of the unlined sewerage pipe networks laid after the Second World War, leading to a higher priority and greater investment in the development of rehabilitation technologies of these mains compared to other assets such as water mains.
- For pressurised pipelines, the result has been:
  - Lack of reliable condition data, with more emphasis placed on elaborate predictive models based on maintenance history rather than on quantitative or visual (CCTV) data;
  - Lack of appropriate, low cost systems for access, maintenance and rehabilitation;
  - An asset management approach based on low maintenance, reactive repair and wholesale rehabilitation or replacement which results in:
    - ✓ Short-term reductions in maintenance costs but whole-of-life costs which are far from optimised;
    - ✓ Reduced levels of service to customers;
    - ✓ A high risk of localised or generalised pipeline failure and the associated risk of damage, loss of water and loss of credibility with customers and owners.

Asset Optimisation Techniques for the 21st Century

Highly functional, adaptable technologies - selective lining vehicle

The asset optimisation techniques and equipment developed and patented by the Corporation provide proven cost-effective solutions to all these problems and will have a dramatic impact on the way large diameter pressurised pipelines will be managed in the future.

THE ASSET MANAGEMENT PLANNING AND REFURBISHMENT PROCESS

The Problem

The Water Corporation serves an area as big and varied as Thailand, Malaysia, The Philippines, Singapore, Vietnam and New Zealand combined. It owns and operates over 42,000 km of pipelines including several long distance large diameter trunk water mains.

Increasing frequency of leaks and bursts due to internal and external corrosion mean increasing maintenance costs and reduced levels of service indicating the pipelines are reaching the end of their economic lives. A prime example is the Goldfields Pipeline between Perth and Kalgoorlie. At 100 years old and 557km in length, this pipeline is one of the oldest and longest water pipelines in the world, an engineering landmark masterminded by the brilliant engineer CY O'Connor. To protect the inside of the pipe from corrosion, the pipeline was one of the first of its kind in the world to be lined with cement mortar, all 557km of it by hand, back in the 1930's. The pipeline now supports over Aus$2.5 billion of economic activity a year from the thousands of farms, towns and mining concerns that have sprung up along its length.

After 100 years, 320km of the original pipe remained in service. The 60-year-old internal lining was breaking down resulting in internal corrosion that threatened catastrophic failure of long sections of the pipeline. The replacement value of the pipe was a massive Aus$160million.

The Corporation therefore embarked on a nine-year programme of innovation to develop systems and processes to optimise the whole of life cost for this asset and others of its kind worldwide.

Asset Management Plan (1992 – 93)

The first step was to undertake a comprehensive condition assessment of the pipeline using all available and viable internal, external and non destructive testing methods. The result was that 70 kms of the pipeline was in urgent need of rehabilitation if the pipeline was to be salvaged;

A world-wide review of available technologies found no technically and financially viable solutions existed to refurbish this type of pipeline. Just as the pipeline was one of the first to be cement mortar lined, so this lining was one of the first requiring to be refurbished. The report therefore recommended in-situ wholesale refurbishment based on development of a method for removal of the existing lining by high pressure water blasting and lining reinstatement using the traditional centri-line method;

The estimated refurbishment cost was $300/m compared to the benchmark cost of total pipe replacement of $500/m.

Wholesale Refurbishment Programme (1994 – 95)

The next step, commencing in 1994, was to complete a 7km trial to develop and prove the technical and financial viability of the proposed technologies.

Following the successful trial, ***16km of pipeline was refurbished in 1995 at an overall cost of $275/m.***

Renewal Strategy Review (1996)

Based on the experience gained during the first two years of successful wholesale refurbishment, a further review of all available renewal strategies was undertaken to determine if further improvements could be made. The main findings were:

- The condition of the existing lining was highly variable due to differing standards of quality control, application methods and raw materials used in the original hand applied lining process. Over 98% of the lining was intact with an estimated residual life varying anywhere from 0 years to 40 years or more;
- The frequent and dramatic pipe bursts which made refurbishment necessary were due to localised failures only at the weak points in the pipeline ie. thin or poor quality lining at circumferential and locking bar joints and at discrete sections of pipe;
- Where the lining was still intact but had lost its alkilinity, localised pitting corrosion had occurred with a maximum pit depth of 2.5mm (ie. 4mm of steel remained so that the structural integrity of the pipe was not significantly compromised). Refurbishment was therefore still a technically viable option;
- The residual life of the steel shell, after the lining was lost, was still in exccess of 20 years (corrosion rate = 0.2mm/year approx.);
- ***If a selective refurbishment could be developed at a predicted cost of $50/m, selective refurbishment would be viable if the $275/m cost of wholesale refurbishment could be defered by > 10 years.***

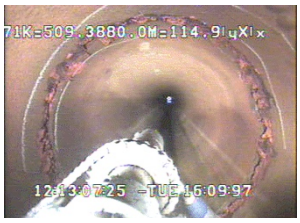
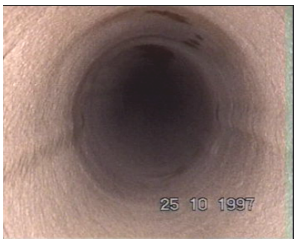
Selective Refurbishment Programme (1997 – 2000)

The next step was to develop processes and equipment suitable for selective refurbishment. The technologies required for this application were far more sophisticated than those developed for wholesale refurbishment. Over the past four years, these technologies have been progressively developed, trialed on site, and continually improved. The result of this four year journey is a suite of techniques and equipment for:

Condition Assessment - assessing, monitoring and reporting on the condition of pipelines over their asset lives and in varying environment such as charged and uncharged mains;

Financial Modelling - to facilitate the selection and management of the optimum combination of the renewal processes;

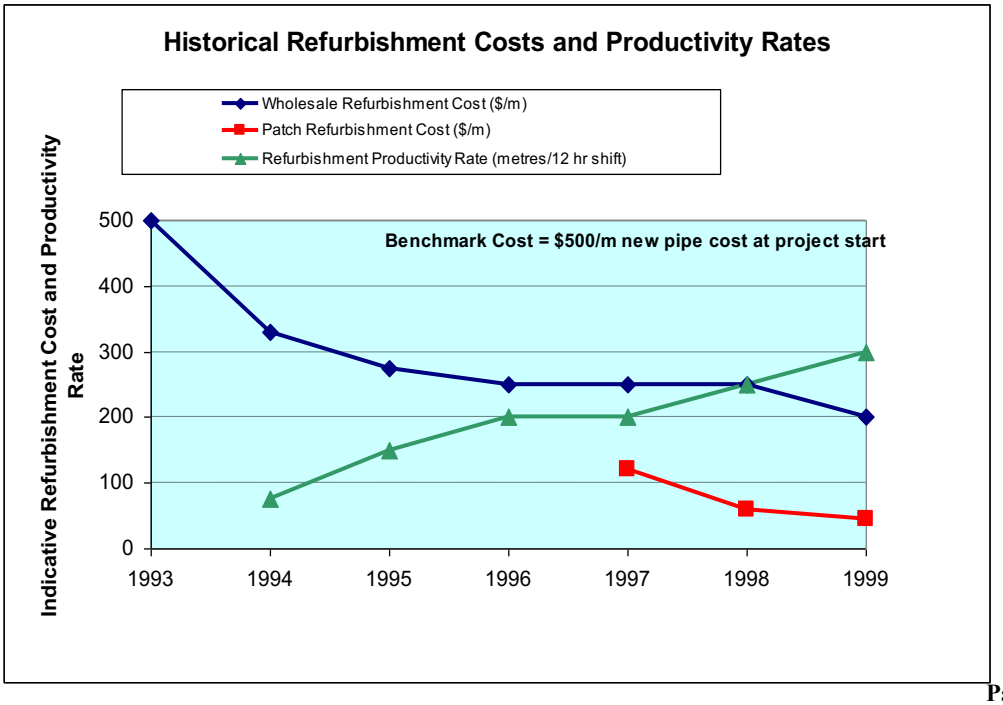
Refurbishment – a full range of equipment has been developed that can adapt to varying pipe sizes and is flexible enough to undertake either selective or wholesale refurbishment.

SELECTIVE REFURBISHMENT		WHOLESALE REFURBISHMENT
 "Minor" burst	**THE SYMPTOM**	 "Major" burst
 Localised defect – general lining good	**THE CAUSE**	 General loss of lining
 Localised "selective" refurbishment.	**THE SOLUTION**	 General "wholesale" refurbishment

THE RESULTS

The 70kms of pipeline identified from the 1992 – 93 Asset Management Plan has been refurbished. Actual costs and net present costs have been dramatically reduced whilst safety and quality have been continually improved;

Actual Costs

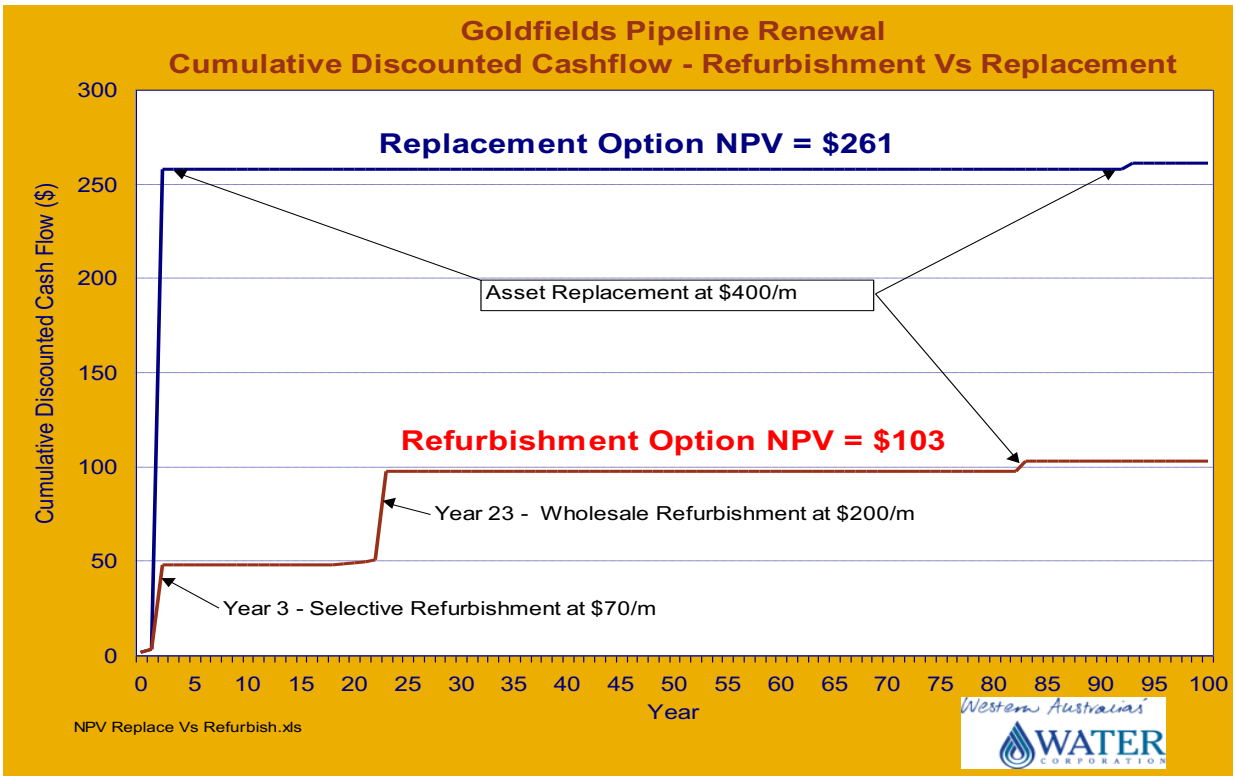


Cumulative Discounted Cashflows

The chart below indicates the cumulative discounted cashflows for refurbishment compared to replacement for the Goldfields Pipeline based on:

Renewal Type	Cost	Assumed Life
Replacement	$400/m	90 years
Wholesale Refurbishment	$200/m	60 years
Selective Refurbishment	$70/m	20 years

The main benefit in terms of net present costs results from the deferal of the major cost of wholesale refurbishment or replacement until Year 20 or beyond. This has the added benefit of likely improvements in technology over this period and consequent reductions in costs. For the refurbishment option, the chart assumes the lining is wholesale refurbished in Year 20. In reality, it is quite likely that the pipe could once again be selectively refurbished in Year 20, thereby again reducing the cumulative net present cost of the refurbishment option.



LESSONS LEARNT FROM ASSET MANAGEMENT PLANNING EXERCISES

1. ***Guard against "The Pipeline's F****d, Replace It" syndrome;***

2. ***The steel pipe shell and the internal cement mortar lining are separate assets - Don't renew the expensive asset (steel shell) because of failure of the cheap asset (lining);***

3. ***Don't renew the whole lining when only localised (albeit dramatic) failures are occuring;***

4. ***Don't renew the asset without a full internal inspection and thorough review of the whole-of-life cost-benefits of Selective Refurbishment versus Wholesale Renewal.***

EQUIPMENT CAPABILITIES

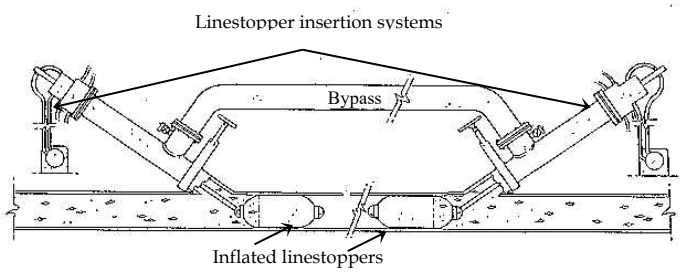
Pipeline Access

In order to provide prolonged access to the pipeline for condition assessment, maintenance and renewal activities to proceed, a technique for stopping and bypassing the pipe flow was required which minimised interruption to pumping operations and customer supply.

Stopping the Flow

A hot-tapping and linestopping system was developed to enable the flow in the pipe to be stopped whilst under pressure and to provide a watertight seal without damaging the fragile pipe. This versatile system has since been patented world-wide and allows the stopping of flows in 450mm – 1050mm diameter pipe despite physical protrusions such as out of roundness, locking bars and damaged lining or lining debris.

Hot-tapping the 450mm dia hole



Linestopper and bypass arrangement

Reinforced rubber linestoppers

Bypassing the Flow

In order to minimise the cost of providing access to the pipeline to enable condition assessment, maintenance and renewal activities to proceed with minimal customer supply constraints, highly mobile bypassing systems have been developed. These 1.5km long bypass systems include:

- 450mm steel pipes with flexible couplings (max operating pressure > 2000kPa) mounted on wheels allowing the bypass to be relocated in one pull using a grader or similar high traction site plant;
- 300mm lay flat hose (max operating pressure = 1000kPa) with quick release couplings located on truck-mounted reels for speedy deployment, retrieval and relocation.

A leapfrogging system of bypasses is used to ensure a continuous supply of water to customers whilst maximising the utilisation and productivity of the assessment/maintenance/renewals crews.

Grader relocating the 1.5km long steel bypass

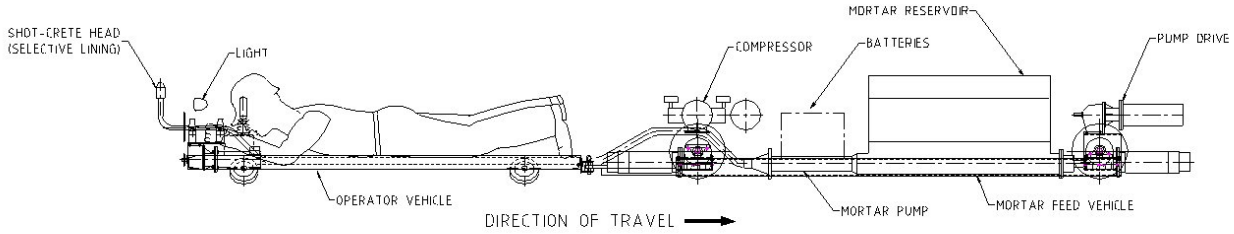
1.5km x 300mm lay flat bypass (reel storage & deployment)

Condition Assessment and Refurbishment Equipment

Design Features – Self Powered Vehicles

The Corporation has developed a series of sophisticated special purpose vehicles that are highly controllable and can operate safely inside the pipe. All vehicles are self-powered and trailing hoses and umbilicals have been eliminated, wherever possible, to reduce equipment and labour costs associated with deployment and retrieval and to minimise safety risks associated with entanglement. These vehicles are essential to the rapid low cost maintenance and/or refurbishment processes. In order to reduce health and safety risks associated with men working in confined spaces, the vehicles are fully automated to minimize manual effort and reduce the amount of time required for operators inside the pipe. Where essential for safety reasons, the equipment has been made fully remote controlled. The remaining equipment and processes could also be made fully remote controlled if required to totally eliminate all risks associated with operators working in confined spaces and to comply with the differing safe working practices

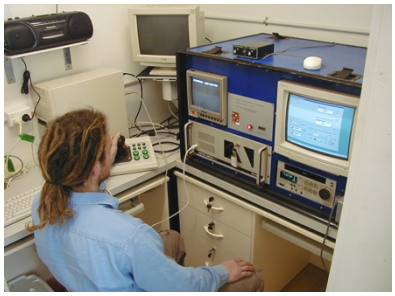
elsewhere in Australia and overseas. Currently operators working inside the pipe are still acceptable in Western Australia based on strict Operations and Safety Procedures and compulsory training in a nationally accredited Confined Space Entry course.



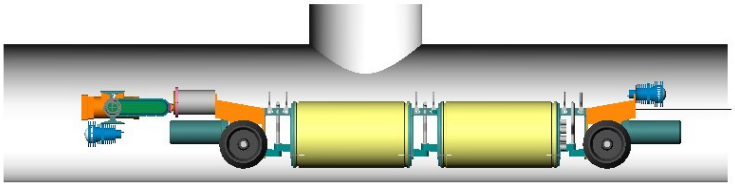
Typical man operated refurbishment vehicle – selective lining vehicle comprising mortar feed vehicle and operator/application vehicle

Remote Controlled Condition Assessment – Fully Charged Mains

A sophisticated remotely operated vehicle (ROV) has been developed for closed circuit television (CCTV) inspection and condition assessment of pipelines for a distance up to 5km from the point of entry. The vehicle can be launched into fully charged water mains, via existing manholes, thereby enabling quick and cost-effective inspections without the time-consuming process of draining and recharging the main. The ROV has been designed as a platform for further sophisticated diagnostic capabilities such as sonar, ultrasound, and laser to be added in the future. With the application of existing proven technologies and further research and development where required, this diagnostic capability will complement the CCTV system to offer a comprehensive remote condition assessment capability.



Remote ROV operation & condition assessment

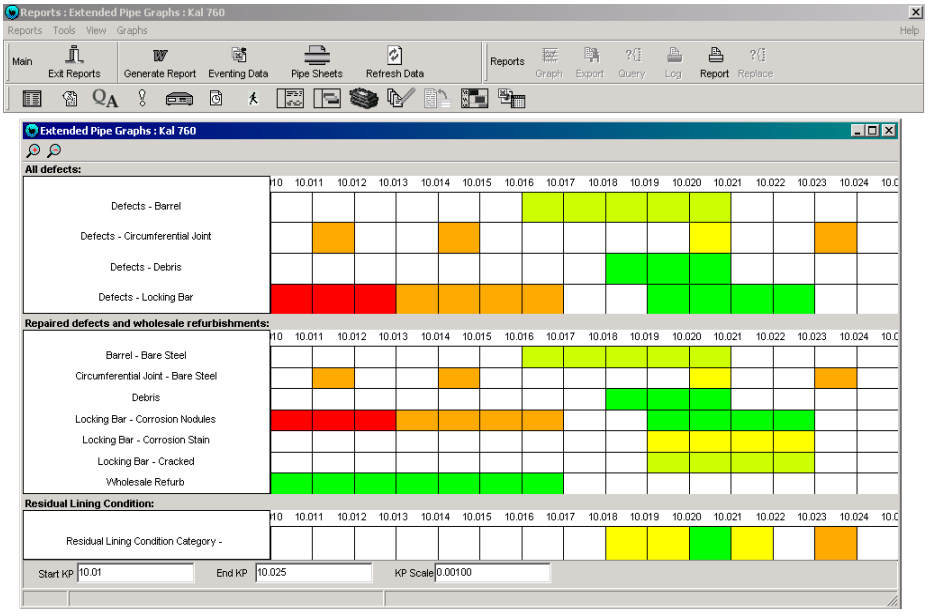


CCTV & condition assessment ROV with 5km fibre optic umbilical

Other initiatives to enhance the functionality of this system are under review including adapting the long-range ROV to include tooling modules such as manipulator arms, water blasting and lining equipment.

Remote Controlled Condition Assessment – Discharged Mains

Condition assessment of discharged mains is undertaken using the high pressure (HP) Blast ROV (refer Pipeline Cleaning section below). This vehicle can inspect mains 600mm in and larger up to 10km from the point of entry.



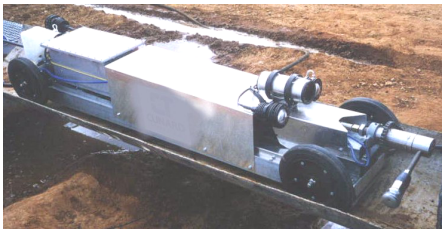
Condition Assessment Software

The condition assessment software provides the basis for assessing, monitoring and reporting on the condition of the asset before and after refurbishment. It is the key to selecting the optimum blend of selective and wholesale refurbishment required to minimise whole of life costs for

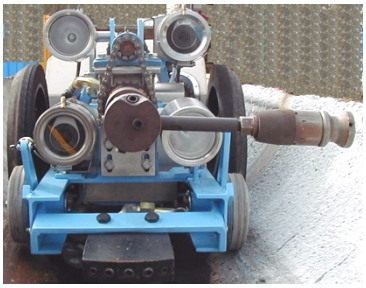
the asset. The software allows real time logging of condition data with either ROV and is highly functional, customisable and user friendly. The condition database can be provided to the client in excel format including all condition data, video logs, and hyperlinks to all defect still images and video files.
The sample reporting output above shows the data logged for before and after the selective refurbishment process as well as the residual lining category that reflects the estimated life of the lining not renewed. Data from subsequent inspections can be merged to assess degradation of lining and/or steel over their asset lives. The software is an essential tool for both condition assessment and detailed job planning for refurbishment site works.

Pipeline Cleaning and Surface Preparation
The surface preparation process uses water blasting at pressures up to 30,000psi from a remotely operated vehicle to remove failed or defective areas of lining and corrosion deposits from the internal surface of the pipe without damaging the underlying steel. This highly effective method removes all deleterious material leaving behind a quality bare steel surface ready for subsequent application of the new lining.

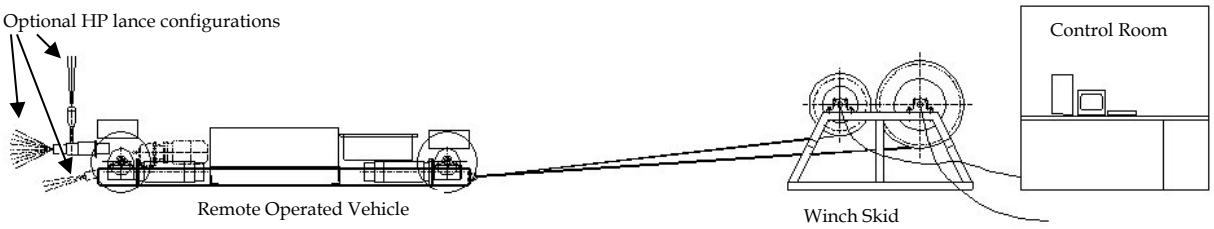
Winch Room



Remote Operated Vehicle (ROV)



Front end of HP Blast ROV



High Pressure Cleaning System General Layout (Pump not shown)

Debris Removal
After surface preparation, the debris and detritus is left on the invert of the pipe. The amount and concentration of this debris depends on the extent of the defects e.g. in the case of wholesale refurbishment, this can weight many tonnes. Several techniques have been developed to suit the varying circumstances and particular site constraints. For bulk debris removal, these include winched bucket (drag-line) systems and a self-powered scraper/conveyor vehicle. For removal of fine debris and water, systems include flushing using the HP Blast ROV and pigging (winch drawn or attached to the ROV). A self-powered vacuum/wash vehicle is used for the final clean leaving the surface thoroughly clean and dry ready for relining.

Removal of large debris using scraper/conveyor vehicle

Flushing fine debris using ROV

Application of the New Lining

Where wholesale or 360 degree lining is required, the traditional centri-line process is utilised and the lining is trowel finished. Where selective lining is required, a shot-creting method is used.

The lining vehicle comprises of a mortar feed vehicle and an operator/application vehicle (refer earlier diagram). To avoid the need for the lining machine to exit the pipe after each batch of mortar is used up, a separate mortar transfer vehicle is used to refill the reservoir of the lining vehicle. Once again, all vehicles are self-powered with no trailing hoses or umbilicals.

A specially formulated mortar mix, combined with state of the art motor control technology, produces a high quality trowelled finish that meets or exceeds all key performance criteria and standards for both factory applied and in-situ linings.

Refilling the mortar reservoir at the pipe cut-out

The Total Solution Service

Each of the above capabilities gives the Corporation a distinct market edge in the direct application of those technologies. However, the combination of all the capabilities enables a total solution service to potential clients offering a unique asset management optimisation solution encompassing inspection, condition assessment, asset management planning as well as the ultimate customised maintenance and/or renewal solution.

Summary of Current Capabilities

Pipe sizes	Generally 450-600mm diameter and above
Pipe materials	Steel, ductile iron, malleable iron, concrete, asbestos cement
Pipe types	Riveted, welded, locking bar, spiral welded, formed, reinforced
Construction	Above or below ground
Internal problems	Local or generalised failure – lining ineffective, corrosion, growths, blockages, etc
Blasting pressures	Up to 30,000 psi (2000 Bar)
Equipment ranges	• Unlimited for self-powered tether free vehicles • 5km for wet inspections using the CCTV ROV • 10km for dry inspections using the HP Blast ROV • 400 metres for high pressure cleaning using the ROV
Lining types	Cement mortars, epoxies, urethanes

With a dedicated on-going research program, development of equipment and solutions outside the above parameters are continually being reviewed based on market demands.

PROCESSES

This section outlines the steps in the processes from condition assessment through to completion of refurbishment.

Condition Assessment and Asset Management Planning Processes

1. Complete the internal pre-inspection using either CCTV ROV (charged pipe) or HP Blast ROV (drained pipe), logging all defects and completing the video record;
2. Undertake condition assessment (if and as required) using external and other non destructive testing methods;
3. Review condition data and alternative pipeline renewal strategies and estimate costs;
4. Undertake financial modelling to determine the optimum renewal strategy and combination of wholesale refurbishment, selective refurbishment and/or replacement.

Refurbishment Process

1. Utilise the data from the condition assessment process to produce a detailed job plan. This will include the locations for selective and wholesale refurbishment and also the locations of pipe cut-outs required for the ingress and egress of equipment and personnel;
2. Where either alternative supply is available or a short duration shutdown is acceptable, gain access to the pipe by shutting down the pipeline Alternatively, use the mobile bypass with or without hot-tapping and/or linestopping;
3. Remove the pipe cut-outs at the locations determined from the detailed job planning;
4. Clean and log only the defects areas to be repaired;
5. Clean the surface of the residual lining (as required) to improve water quality;
6. Take a video record of the condition of the residual lining after cleaning (or after relining if preferred by the client);
7. Review condition database and video record and assign residual life categories to the lining not renewed (this can be subsequently reviewed and amended in consultation with the asset manager).
8. Remove bulk debris;
9. Remove fine debris and water;
10. Reline the repair areas;
11. Reinstate access cut-out pipes and reline the adjacent joints;
12. Disinfect and recharge the line.

INDICATIVE COSTS OF INDIVIDUAL PROCESSES

The costs shown below are indicative based on the actual costs for the Goldfields Pipeline Project. Costs will vary significantly dependant (inter alia) on the pipeline condition and the scope, constraints and contractual (risk sharing) arrangements for specific projects.

Process	***Corporation's Techniques***	***Conventional Techniques***
CCTV Inspection	<$5/m	$10/m - $15/m for scour, remove manholes, inspect, disinfect, refill, etc;
Condition assessment	Rapid low cost collation of all internal and external (where not buried) data into electronic data suitable for analysis**	Typical costs not known
Bypassing	< $10/m	More expensive – costs depend on required duration
Selective Refurbishment	$70/m incl. of all costs	No known technologies. Estimated cost >$150/m for comparable work
Wholesale Refurbishment	$200/m incl. of all costs	>$300/m

The strength of the Corporation's processes and equipment is that they facilitate a truly optimised asset management solution. The condition assessment and financial modelling ensures the optimum renewal option is selected whilst the refurbishment equipment economically undertakes both selective and wholesale refurbishment. Thus only the failed lining is refurbished leading to significant cost savings, as this lining is easiest and quickest to remove.

** Notes regarding condition assessment and diagnostic data

1. With the development initiatives planned over the next two years, the long-range CCTV based ROV systems should allow more rapid and cost effective collation of diagnostic data than traditional methods such as intelligent pigging or localised non-destructive testing methods.
2. The need for extensive (and expensive) diagnostic data for internal condition assessment is questionable given the low cost inspection and refurbishment techniques offered in this paper. The problem areas in the lining will be readily identifiable

using the CCTV techniques and readily repairable using the refurbishment techniques. Also the consequences of any localised failures, should they occur, which might be missed by such methods are generally low for water pipelines.

OTHER BENEFITS OF THE EQUIPMENT AND PROCESSES

Quality

Cement mortar lining is still the lining of choice for owners and operators of ferrous pipelines, for both factory and in-situ application, based on its proven performance over 70 years in the field all over the world. Modern coatings such as epoxies and urethanes are less suited to in-situ application as they are generally highly sensitive to atmospheric conditions and surface preparation and to the integrity of the coating, i.e. the lining can fail if water ingresses through localised air pockets or blisters in the coating. Many of these products have failed within the first 20 – 30 years of their lives and none can boast the 70-year track record demonstrated by cement mortar. This product is ideally suited to in-situ application because it is far less sensitive to variations in atmospheric conditions and surface preparation. Also, its performance does not rely on the integrity of the coating since corrosion protection is provided by the chemical action of the cement, and cracks up to 2mm in width will close through the process of autogenous healing.

Other Benefits

Environmental and Public Relations:

- Wholesale refurbishment consumes less raw materials than replacement;
- Selective refurbishment consumes less raw materials than wholesale refurbishment;
- Water conservation through reduced corrosion and consequent minimisation of leaks and bursts;
- A reduction in highly visible bursts occurring in water mains will improve the public credibility of pipeline owners and operators;

Hydraulic Efficiency - is improved and pumping costs reduced through the removal of lining debris from the pipe and the improved friction coefficient of the resulting smooth lining compared to rust tubercules on damaged or unlined pipe;

Water quality - is improved through removal of rust deposits and bacteriological slime from the pipe walls and removal of lining debris and sand from the invert of the pipe.

Risk Management - The process of risk management for strategic pipelines is greatly facilitated through the improved condition data from the condition assessment process.

APPLICATIONS – PROVEN AND POTENTIAL

Proven Applications

Applications where the developed technologies have been proven to date include:

CCTV Inspection – water mains, dam outlet pipes;

Linestops – water and sewerage mains, dam and reservoir outlets;

Bypasses – planned and emergency water bypassing;

Refurbishment – selective and wholesale for 600mm and 760mm MSCL water mains:

In-Situ Lining of New Pipe- 105km x 1400mm diameter Harvey Pipeline

Rebuild of lining equipment for 1400mm Harvey Pipeline work

Rendering of welded joints - Machines were reconfigured to:

- Travel 20km without ingress/egress points in the pipe;
- Navigate short 90degree horizontal radius and 30 degree vertical bends;
- Navigate 900mm section valves;
- Access for clean up of lining equipment was via existing manholes and scour points only.

Rendering of Murray River Crossing Pipeline **-** heavy gauge structural pipe couldn't be factory lined due to the thickness of steel and due to the cranage problems caused by the additional weight of lining. Machines were reconfigured and the mortar enhanced to improve thickness control, surface finish, bond and shrinkage control.

Potential Applications
The key strength and marketable value of the equipment is in its adaptability. The vehicle development process has included solving all the issues associated with power, control, data feedback, video, lighting, and umbilical design. The knowledge and expertise gained through this development process allows quick and efficient design and construction of new special purpose vehicles to undertake any specific tasks required by a client to suit his particular problems. This means that customised, cost effective maintenance and/or renewals solutions can be offered for pipes from 400mm diameter and above for a wide variety of materials, construction and lining types.

SERVICES AND CAPABILITIES OFFERED

Customised Solutions - Internal development capability and dedicated R&D budget facilitates customised solutions to suit particular project or client needs;

Condition Assessment, Asset Management Planning, Pipeline Access, Maintenance and Renewal - proven performance and continuous improvement over 9 years and 50km of refurbishment;

Commercialisation of Technologies and Capabilities:
- Technologies are patented and suitable for immediate commercialisation;
- Water Corporation is keen to commercialise all capabilities within Australia and overseas;
- Suitable commercial arrangements are being reviewed (eg. Joint Ventures, Strategic Partnerships, Licenses/Agencies)
- Suitable commercial partners are being sought. Interested parties should contact:

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CONCLUSION

Pipeline refurbishment is not a new concept, particularly for gravity or small diameter pipelines. However, the techniques and equipment available for condition assessment and refurbishment of large diameter pressured pipelines have been strictly limited. The Water Corporation has developed a unique suite of inspection, assessment and refurbishment equipment and processes that offers extensive savings to operators of pipelines both now and in the future. Whether your pipeline is new and requires in-situ lining, or it is at some intermediate age and requires condition assessment and possible refurbishment, there is now a range of economic solutions available.